CONTINGENCY RATION FOR CALIFORNIA SEA LIONS (ZALOPHUS CALIFORNIANUS)

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by

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Undersea Surveillance and Ocean Sciences Department

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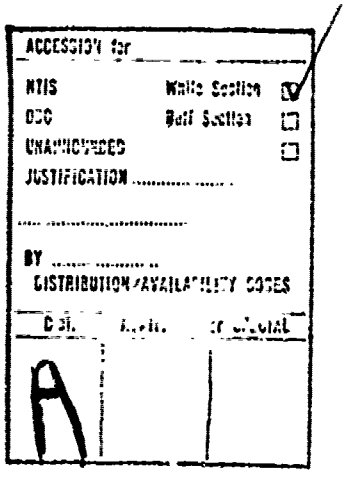

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13 ABSTRACT

This report describes the formulation and preparation of a prepared ration for short term feeding the California sea lion (*Zalophus californianus*).

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SUMMARY

PROBLEM

To develop a sea lion ration which will be stable in storage at ambient temperatures, thereby eliminating the logistics problems associated with supplying fresh frozen fish during operational deployment, and which can serve as an emergency food for short-term use whenever required.

RESULTS

The ration developed is easily prepared from premixed ingredients and can be utilized for at least 4 weeks as the total ration for the California sea lion. All ingredients except the animal fat can be kept at ambient temperatures for prolonged storage periods if protected from moisture. The animal fat (lard) is readily available commercially, but requires refrigeration if held for any length of time. If necessary, hardened vegetable shortening can be substituted for the lard.

The ration must be handled as a fresh perishable food after reconstitution with water.

RECOMMENDATIONS

1. Improve the present ration to increase animal acceptability and convenience to the trainer.

2. Use a greater number of animals on a paired-feeding trial of the improved ration.

3. Test the ration on the bottlenosed dolphin (*Tursiops truncatus*) and pilot whale (*Globicephala scammoni*) and make any necessary formula changes.

4. Use data acquired from the feeding of this ration as a step toward elimination of the necessity of feeding frozen fish to the marine mammals held in NUC facilities.

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CONTENTS

INTRODUCTION

The logistic advantage of a prepared ration over fresh frozen fish became obvious soon after research on marine mammals began at the Marine Bio-Science Facility at Point Mugu, California. In later developments, the use of sea lions in object recovery tasks, as demonstrated by "Project Quick Find" (Ref. 1), further emphasized the need for an easily maintained ration. Natural foods such as fish and squid are less than perfect in other respects also. Problems related to feeding of defrosted frozen fish include histidine decarboxylation to form histamine (Refs. 2, 3), viable parasitic ova and larvae that survive freezing (Ref. 4), vitamin-destroying enzymes reported in defrosted fish (Ref. 5) and other nutritional losses in fish after relatively short frozen storage.

An additional advantage of a prepared ration is that quality control can be exercised in its production, thus giving a uniformity to the product, including such desirable features as tested nutritional and organoleptic characteristics, control of pathogenic microorganisms and parasites through pasteurization, stability after prolonged storage, and trainer convenience.

Formulation of rations for marine mammals is made difficult because of inadequate knowledge of factors affecting acceptance or rejection of food by these animals. Also, very limited data on the nutritional requirements of the animals are available. Because of the intestinal disaccharidase deficiency in the sea lion (Ref. 6), ration formulation must be designed to keep the carbohydrate level of the ration down to levels tolerated by the animals.

Care must be taken in the preparation, storage, and handling of the prepared ration to assure that food-borne illnesses caused by bacteria or their toxins are prevented.

As early as 1968, dolphins (*Tursiops truncatus*) and California sea lions (*Zalophus californianus*) at the Marine Bio-Science Facility at Point Mugu, California, were conditioned to accept foods other than fish as their entire diet or some portion thereof (Ref. 7). The present study built upon this earlier work, and the resulting formulation combines satisfactory organoleptic, nutritional, and storage characteristics to fulfull requirements for a contingency ration.

METHODS AND MATERIALS

Preparation of the ration requires two pots, each large enough to hold the quantity of ration prepared; a large spoon for stirring; a hot plate or other heating source; and shallow pans to hold the mixture for texture development.

Table 1 lists the formulation of the ration. The dry ingredients were premixed and packaged in 1-day ration requirement units. Lard and vegetable oil were weighed and placed

Table 1. Formulated Ration.

One tablet Theragram M* vitamin supplement was added for each 2 kg of ration.

Quantity (pt)	Ingredient
100	Fish protein concentrate
100	Fish meal (minimum 55% protein)
40	Gelatin (40 bloom)
65	Lard
15	Cottonseed oil
9	Sodium alginate
3	Sodium tripolyphosphate
700	Water

*E. R. Squibb & Sons, Inc.

in suitable containers well ahead of preparation time. In order to prepare the ration, the lard, vegetable oil, and water mixture was brought to a boil. The boiling mixture was slowly poured over the dry ingredients, with mixing, then left for 30 minutes in the closed pot in order to allow an adequate time-temperature period for pasteurization (see Discussion). The mixture was then poured into a shallow pan and placed in a refrigerator for several hours or overnight to allow development of texture. Following removal from the pan, the ration was cut for feeding, usually in 3/4- to 1-inch cubes.

Based upon previous observations, 1.5 percent of the wet weight of the ration was used as the maximum quantity of carbohydrate fed. Carbohydrate in excess of this amount frequently produces diarrhea in California sea lions.

The ration was designed to approximate the total caloric value of jack mackerel (*Trachurus symmetricus*), thus making the test ration and control ration as close to equal as possible in nutritional value per unit of weight. However, no chemical analysis of the ration was performed, and without such analysis the caloric similarity can only be approximated.

Observations during the month preceding the feeding study indicated that the subject animals would consistently consume 2.5 kg of fish per day before they began to waste a portion of the fish. Thus 2.5 kg was selected as the quantity of ration fed to each animal.

In a 5-day period preceding the trials, the two animals scheduled to receive the prepared ration (the test animals) were conditioned to accept the ration as a portion of their diet. This was accomplished by using cubed portions of fish as a reinforcement for acceptance of the ration. The test sea lions were returned to a fish diet for 1 week before the study was begun.

The animals were paired, one prepared-ration test animal and one fish-fed control animal to each 3.5- by 2.9-meter cage. Each cage contained a 1.8- by 1.2-meter tank of seawater 0.9 meters deep.

Before the morning feeding all animals were weighed. Then the animals on the prepared ration were hand-fed all the ration they would accept, up to 2.5 kg. If they ate less than 2.5 kg, a second feeding was offered in the afternoon. Later in the study the prepared ration was occasionally offered in a bucket rather than by hand. In either case, the control animal was then fed a quantity of jack mackerel equal to the quantity of ration consumed by its cage mate. All animals were fasted on Sunday.

Blood samples were collected from all four animals before the paired-feeding study began, but from only the prepared-ration animals following the 28-day study (Table 2). Results were compared to normal values for the species (Ref. 8).

Table 2. Test Animal Blood Chemistry.

Test	No. 389	No. 390	No. 392	No. 397	
Before ration feeding (9/23/71)					
SGPT (international units)	17	21	19	21	On fish
Total cholesterol (mg %)	153	192	168	238	
Creatinine (mg %)	0.4	0.6	0.6	0.8	
Serum lipase (Cherry-Crandell units)	0.6	0.1	0.5	0.1	
After ration feeding (11/1/71)					
SGPT (international units)	...	23	...	23	On ration
Total cholesterol (mg %)	...	157	...	175	
Creatinine (mg %)	...	0.9	...	0.8	
Serum lipase (Cherry-Crandell units)	...	0.4	...	0.6	

RESULTS

Figure 1 shows the quantity of jack mackerel or prepared ration eaten by one pair of animals, No. 390 (Carlos) and No. 392 (Ricardo). Figure 2 shows the same data on the second pair, No. 389 (Alberto) and No. 397 (Sofia).

There were no significant differences in weight maintenance between the two sets of animals.

Observations of the animals revealed no noticeable differences in behavior, activity, alertness, or disposition. One possible exception was that the test animals attempted to drink fresh water during pen washing. This behavior was observed only in the fourth week of the study. The significance of this behavior is unknown, since sea lions eating thawed fish sometimes appear to drink fresh water if it is made available. The approximate water percentage in the jack mackerel fed was 78 percent, while that of the prepared ration was 73 percent.

The test sea lions did not consume the ration with as much gusto as the animals eating fish. However, acceptance of the ration increased during the feeding study. The animals accepted the ration from a bucket after the first 2 weeks of the test.

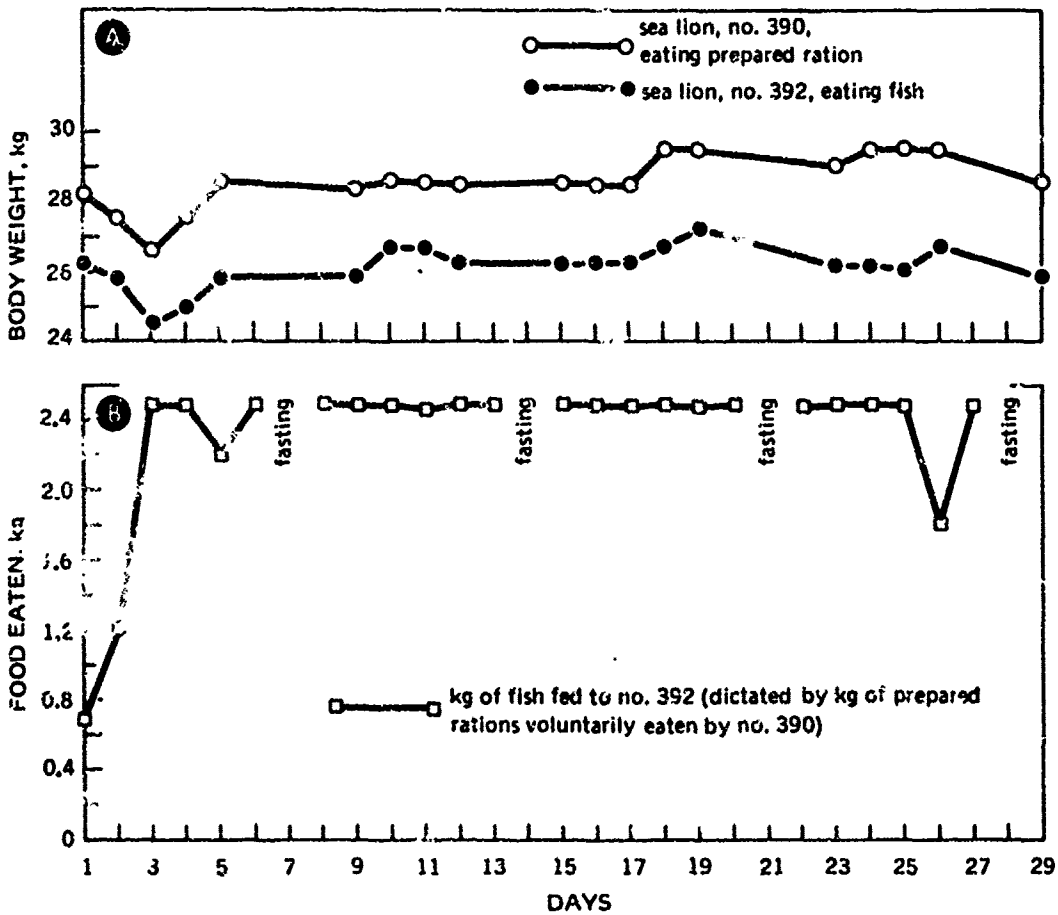

Figure 1. Results of paired feeding. Part A: weight of animals. Part B: weight of food eaten by each animal.

The texture of the prepared ration held up well in water or at ambient temperature for approximately an hour if protected from the sun. Beyond this period cooling was required to keep it from becoming tacky or mushy.

Results of chemical analyses of blood specimens of control animals and test animals were all within the normal limits for the species reported by Ridgway (Ref. 8). The tests were used primarily to detect any liver toxicity that might have resulted from consumption of the prepared ration.

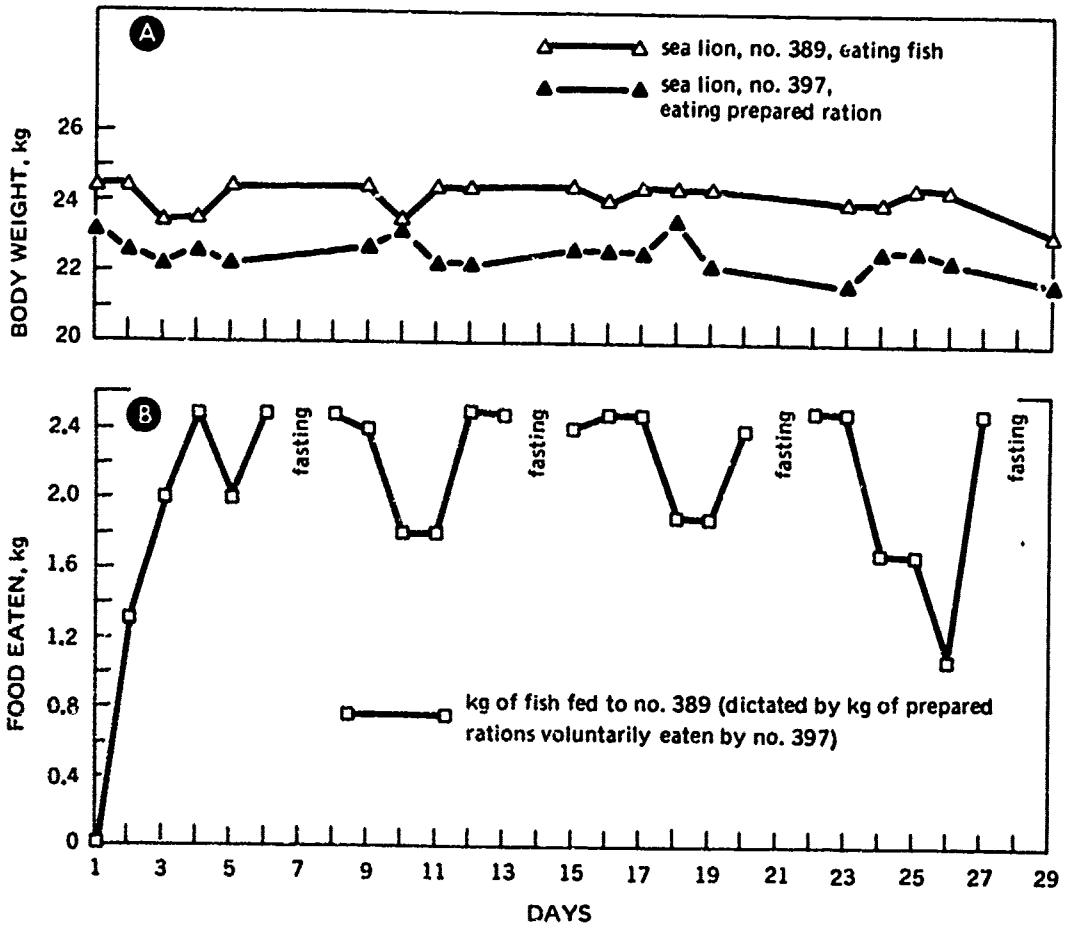

Figure 2. Results of paired feeding. Part A: weight of animals. Part B: weight of food eaten by each animal.

DISCUSSION

The ration developed is prepared from premixed, shelf-stable ingredients which have excellent storage characteristics. It does not become a perishable food until after preparation. Also, since the dry ingredients constitute only about one-quarter of the weight of the prepared ration, a significant advantage is gained in storage and transport.

Pasteurization can be accomplished by using a high temperature for a short period of time, or a lower temperature for a longer period. To insure adequate pasteurization, it is recommended that the mix be held at not less than 82.2°C (180°F) for 30 minutes.

Animal acceptance of the ration was most encouraging. Although the animals ate the test food with less gusto than they display when eating fish, nevertheless their enthusiasm for the prepared food definitely improved during the course of the 28-day study.

The tests were designed to last only 28 days. There was no indication that the animals could not have continued on the ration for a considerably longer period.

The success encountered in this very limited feed trial justifies studies using statistically significant numbers of animals, and adapting the concept of contingency rations to the bottlenosed dolphin and pilot whale.

While the nutritional requirements and organoleptic problems encountered in developing rations for different marine mammals will vary, the California sea lion is an excellent animal to screen rations for possible toxic ingredients. These animals are easily observed for early signs of illness, enabling prompt corrective action. Furthermore, their gluttonous appetite makes them relatively easy subjects to condition to accept a prepared ration.

The texture of the ration could be improved to give greater resilience for a longer period of time after removal from refrigeration. This might also make it more acceptable to the animals.

Careful tests to find a definitive answer to the need to increase the available water in the ration need to be undertaken, although the two sea lions used in this study showed no signs of dehydration.

The cost of ration ingredients used in this study was $0.13 per pound. This could be reduced by purchasing the ingredients in bulk quantities.

The ration can be utilized in its present formulation as a short-term contingency ration. It is shelf-stable, accepted by sea lions after brief conditioning, easy to prepare and use, and relatively inexpensive.

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